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ABSTRACT

Expert systems have made remarkable progress in areas where the knowledge of an expert can be codified and represented, and these systems have many potentially useful applications in education. Expert systems seem "intelligent" because they do not simply repeat a set of predetermined questions during a consultation session, but will have a reason for each question asked based on answers given to previous questions. Simple expert systems can now be created by individuals with little programming experience using authoring tools. Microcomputer-based expert systems provide an affordable way to solve meaningful problems and enhance the problem solving abilities of individuals and organizations. Expert systems can be used in the classroom or laboratory by providing individual consultation sessions with students. Great flexibility is possible with expert systems because a knowledge base embedded in a system is easily modified and expandable. These "intelligent" tutors will develop an internal model of a student and then adapt the instructional technique to fit that individual. In addition, older workers seeking retraining might respond especially well to interacting with an expert system in an on-the-job training program. In the future expert systems will assist administrators with scheduling, budgeting, and program evaluation. The next few years will be interesting and full of opportunities for educators applying artificial intelligence tools in their field. (8 references) (EW)

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Artificial Intelligence in Education

by Kim E. Ruyle

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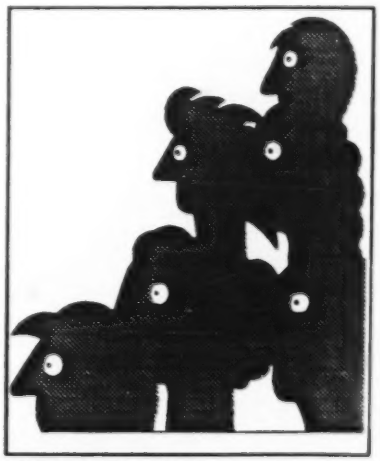
One can hardly pick up a newspaper or magazine lately without encountering descriptions and predictions about artificial intelligence (AI). From what is written, it would seem that AI is soon to penetrate every facet of our lives, substituting and in some cases even replacing human intelligence altogether. Just what is AI? And what impact, if any, might it have on education? How can educators utilize this new technology?

Artificial intelligence is a branch of computer science that is seeking to impart human-like intelligence to a machine. Such a machine would have the ability to communicate freely with humans, to solve the sort of poorly defined problems that only humans can now solve. And perhaps most remarkable, the artificially intelligent machine would have a knowledge base that it would modify according to its own experiences. In other words, the machine would be truly able to learn!

It is hard to imagine the heights to which this type of machine might rise. But for now, artificially intelligent machines can not begin to compete with even a young child's intelligence. However, in some specialized areas in which the knowledge of an expert can be codified and represented, AI has made substantial progress.

This progress is due to the development of specialized computer programs called expert systems. These systems embody an expert's knowledge and, somewhat like expert consultants, can interact with novices to help solve specialized problems. Expert systems have been used for a variety of applications. They have helped, for instance, discover molybdenum deposits, diagnose infections, and optimize a hotel chain's reservation-making system (Waterman, 1986; Bulkeley, 1986).

Expert systems seem "intelligent" because they do not simply repeat a predetermined series of questions during the consultation session. The system will have a reason for each question asked based on answers given to previous questions. It is this feature that sets expert systems apart from conventional computer programs and makes them appear "intelligent."



ETEC 625 students: always attentive

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Dr. Bob Gray: Naturally Intelligent

To illustrate, if you went to the doctor and said you had a sore throat, you would expect the doctor to look in your throat, take your temperature, and maybe take a throat culture. If the information gathered did not indicate a sure diagnosis, more tests would be carried out. You would consider such behavior on the part of the doctor to be "intelligent."

On the other hand, if the doctor began diagnosing your sore throat by checking your reflexes, taking a pap smear, and then X-raying your skull, you might wonder about the training and intelligence of the doctor (or perhaps seriously wonder about the true state of your health).

One way doctors demonstrate their intelligence is by narrowing down a diagnosis given limited information. They do not start with the "A's" in their medical library and proceed to the "Z's" for most problems.

A good expert system is like a good doctor in that regard. The system gathers evidence and uses a heuristic approach to problem solving, asking "intelligent" questions based on the information it has.

Conventional computer programs are algorithmic in nature rather than heuristic. They try every possible path to a solution. And while this is fairly certain to generate a solution, it is very inefficient. An expert system trades the exhaustiveness of an algorithm for the efficiency of heuristics, and is so doing appears intelligent.

One interesting feature of many expert systems is the option given the user of asking questions of the system. At any point during a consultation session, the user may ask why a particular question is used. The system will then display the rule it is acting upon. Rules are if-then statements that comprise the system's "logic." Users can in effect see into the expert system's "brain" and gain an understanding of its operation.

Most early expert systems were written in computer languages that were developed especially for the purpose and they had to operate on very powerful computers. The programming was generally done by a knowledge engineer who worked with a subject matter expert to derive knowledge and codify it in the program. The programming and hardware constraints and associated costs prevented widespread use of expert systems.

The situation has changed in recent years, however. Hardware is more powerful and less expensive, and programming can be greatly facilitated with expert system authoring tools. It is now possible for a subject matter expert to also act as knowledge engineer and create a fairly sophisticated expert system without learning a programming language.

Microcomputer-based authoring tools can not produce expert systems that truly rival sophisticated programs that run on mainframe computers. But that is not their purpose. Microcomputer-based expert systems can solve meaningful problems and enhance the problem solving ability of individuals and organizations. Very importantly, they're also affordable.

Author Kim Ruyle: Artificially Intelligent

Microcomputer-based authoring tools: inexpensive

There are several microcomputer-based authoring tools on the market priced from about $200 to $7000 or more. I used one such tool, EXSYS (Ruyle, 1987), to create an expert system job aid to assist teachers, trainers, and instructional designers in selecting the most appropriate media for a given instructional situation.

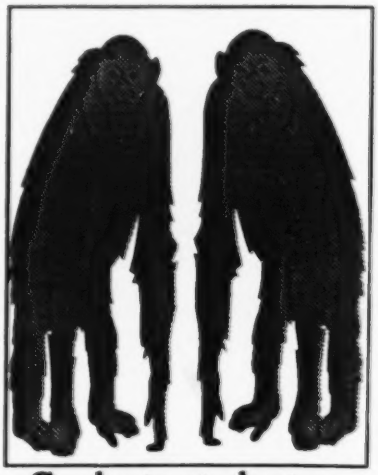
Expert systems can assist instructors in the classroom or laboratory by providing individual consultation sessions with students. Expert systems address real world problems, the kinds of problems so important for motivation. An instructor might, for instance, assign students to work with an expert system to diagnose a malfunctioning electrical circuit, estimate residential construction costs, or select a hair style based on a client's facial features. Already workers in industry are interacting with expert systems on the job to solve complex problems (Waterman, 1986).

While assisting learners with solving real world problems, computer expert systems can model effective problem solving strategies that students will do well to emulate. Most expert systems allow the user (in this case a learner) to question the logic behind the system's problem solving approach. When asked why, the expert system displays the specific rules it is following. These rules are patterned after the heuristic problem solving strategies used by human experts. Heuristic strategies are mental shortcuts and rules of thumb used by experts when solving problems. Very often this kind of knowledge is difficult or impossible to convey in textbooks or lectures. By questioning the system, the learner is given insight into the knowledge and logic that human experts may have taken years to assimilate.

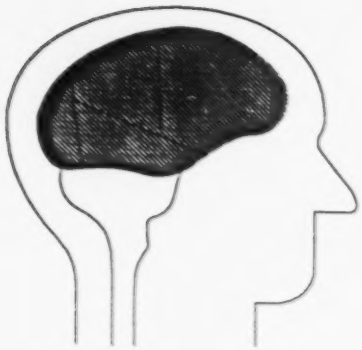
Expert systems are not like the mechanical teaching machines that researchers experimented with in the recent past (Skinner, 1968). Great flexibility is possible with expert systems because a knowledge base embedded in a system is easily modified and expandable. Work is underway to develop tutoring systems that use artificial intelligence techniques to provide the learner with individualized instruction. These "intelligent" tutors will develop an internal model of a student and then adapt the instructional technique to fit that individual (Sleeman & Brown, 1982).

It is not unreasonable to consider the use of expert systems as a type of mentor. After all, an expert system will not have personal biases, will not be moody, will not fail to show up for work because of sickness, and will not withhold tricks of the trade either unintentionally or because of some warped sense of justice that insists that young workers should "pay their dues just as I did."

Older workers seeking retraining might respond especially well to interacting with an expert system in an on-the-job training (OJT) program. OJT is especially effective with adult learners anyway (Carp, Peterson, & Roelfs, 1974), and an older person may feel more comfortable working with a computer expert than with a human expert who might well be years younger.



Graduate students: Artificially intelligent? Naturally intelligent? Intelligent at all?



The human brain: Can a machine ever compete?

Applications such as these are already feasible and likely to become quite widespread as business and industry continue to employ expert systems in their operations. As computing power becomes cheaper, many powerful expert systems will become cost effective, and microcomputer-based expert systems will become much more sophisticated and widely available.

Software developments will also greatly facilitate expert system application. Authoring tools are now available that allow anyone possessing specialized knowledge or having access to a knowledge base to write their own simple expert system. Practically no programming skills are required. Instructors utilizing such authoring tools can create customized expert systems to provide their students with a "tutor" that is extremely flexible and addresses the most relevant of problems (Ruyle, 1986a).

Expert system applications in vocational and industrial education seem almost endless. They address many of industry's training needs and can be especially effective in working with adult learners. Expert systems can be used to model problem solving strategies, provide individualized and flexible instruction and consultation (Ruyle, 1986b). Workers and adult learners seeking retraining or just trying to stay current can benefit from access to expert systems. Expert systems can help these people be more efficient and assist them in reaching higher cognitive levels.

In the future expert systems will assist administrators with scheduling, budgeting, and program evaluation. The next few years will be interesting and full of opportunities for educators applying artificial intelligence tools to their field.

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